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FASCIOLOPSIS BUSKII, F. RATHOUISI, AND RELATED SPECIES IN CHINA

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[WITH TWO PLATES.]

In 1843 Dr Busk discovered a parasite which he took from the duodenum of a Lascar sailor who died in the Seamen's Hospital in London. Lankester (1857) published the original description of this parasite, which he named *Distoma Buskii.* It appears that the discoverer objected to this appellation and in consequence, when the specimen was later described by Cobbold (1860), he gave it the name of *Distoma crassum,* a name which had been preoccupied by von Siebold in 1837 for another species of distome. Moreover, preference has no influence in scientific nomenclature, and the original specific designation must stand. Of the original specimens the majority have been lost. One which was given to Leuckart is figured in his work (1863: 586). A second is preserved in the museum of the Middlesex Hospital, London, and a third in the museum of the Royal College of Surgeons. Two others are in the museum at King's College, making in all only five type specimens in existence.

The second and third cases of the occurrence of this parasite were recorded in 1873 by Leidy, to whom the material was sent by Dr. J. G. Kerr, a missionary physician in Canton. Two others, under the date of 1875, are reported by Odhner (1902); the sixth case under date of 1878 by Cobbold (1879), and the seventh case under date of 1890 by Odhner (1902). This last author made a

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careful study of the structure of the species, which meanwhile had been assigned to the new genus *Fasciolopsis* by Looss (1899), and to him we owe our first accurate data with regard to its morphology. I have found references to cases since that date in India, of which the record is inaccessible to me, and in China, reported by Heanley (1908). In addition to these Looss (1907) has examined about a dozen specimens from Hongkong which are now in the museum of the Liverpool School of Tropical Medicine. According to Heanley these came from the pig. Finally Goddard (1907:196) reports two cases from China.

From correspondence with Dr. W. H. Jefferys of Shanghai, China, who cites the opinions of others as well as his own experiments in China, it seems clear that this species is far more abundant and of much greater importance than has hitherto been believed. I have myself received specimens from Dr. Jefferys and can confirm the reports of Odhner and Looss with regard to its morphology. The characters of the genus and of the species may be outlined as follows:

FASCIOLOPSIS LOOSS, 1899.

Fasciolinae without anterior region clearly set off from rest of body. Cuticula smooth. Acetabulum powerfully developed, with cavity extended posteriad as sacculate invagination, and much larger than oral sucker. Intestinal crura simple, slender, wavy, but without evaginations. Testes dendritic, with branches growing smaller toward distal ends. Cirrus pouch very long, cylindrical, containing spiral tubular seminal vesicle with peculiar caecal appendage. Cirrus closely covered with fine spines. In alimentary canal of mammals. Type species *F. Buskii.*

FASCIOLOPSIS BUSKII STILES, 1901.

Syn: *Distoma Buskii* Lank., 1857; *D. crassum* Cobbold, 1860, nec v. Sieb. 1837.

Length 24 to 45 mm., or even 75 mm. (Busk), usually about 30 mm.; breadth, 6 to 16 mm., usually 10 to 12 mm.; maximum thickness, 1.5 to 4 mm. Body moderately elongated, nearly regularly oval, ventral surface flattened, skin without spines.[1] Oral

1. Odhner and most others say the cuticula is without any sort of armature, but Heanley states most positively that it has spines, whether taken from man or pig, although they are very difficult to find in some mounted specimens.

sucker 0.5 mm. in diameter, completely ventral; acetabulum separated from anterior end by about its diameter, 1.6 to 2 mm., with deep triangular lumen extending caudad. Pharynx large, powerful; prepharynx present. Esophagus very short, intestinal crura slender, extending to posterior end, with two characteristic curves toward the median line, one at center of body, the other between the testes. Genital pore immediatly anterior to acetabulum. Cirrus sac cylindrical, median, prominent, extending from acetabulum about half way to shell gland. Testes, dichotomously dendritic, posterior to transverse yolk duct and in median field, one behind the other. Germarium small, dendritic, just anterior to transverse yolk duct on the right side. Laurer's canal present, but receptaculum seminis wanting. Uterus in irregular open coils anterior to ovary. Vitellaria well developed, with minute acini, extending from acetabulum to posterior end where they merge, although the band is nearly interrupted at the posterior end in the median line. Eggs very thin shelled, 120-130 microns long by 75 to 80 microns broad, with minute operculum and finely granular contents. Development unknown.

Parasitic in the duodenum of man in India, Siam, China, Assam, and Sumatra, according to various authors. Very common in South China pigs (Heanley).

The presence of this parasite is said to be accompanied with high temperature (to 106° F.), bloody diarrhea, emaciation, tympanic abdomen, edema, in general, typhoid symptoms. Several of the cases have terminated fatally, owing, in part, at least, to the late date at which treatment was sought.

Calomel, thymol with castor oil or salts, and eucalyptus oil have all been used with success to expel these parasites.

It is important to note here the various records concerning the occurrence of this species in the United States which are to be found in the literature. The first of these is given on the authority of Leidy (1891), where the parasite is listed under the name of *Distomum crassum*. In fact, as early as 1873, he reported the specimens which in this later paper he places in the species named. The material, as already noted, came from Dr. J. G. Kerr of Canton, China, and was vomited by a Chinese boy. A girl of English parentage, in Canton, is also recorded as having passed the same parasite from the bowels. While first recorded in our literature,

it should be noted that the parasites were not obtained on this continent, but were sent here for determination merely. These are the only specimens which Leidy reported from the human host.

In the same paper, and immediately in connection with these specimens of *D. crassum* from man, Leidy also records that he had received specimens of this parasite from New York, Arkansas and Texas, where they were found in the liver of a doe (N. Y.) and of cattle (Ark. and Tex.). Although Leidy says these specimens preserved in alcohol "appear to be identical with *D. crassum,*" and, though they have frequently been recorded under this name, yet they do not actually belong to the species under consideration. The forms in question were in reality *Fasciola magna,* a species which is now well recognized as a parasite of American herbivora.

On the other hand, the probable introduction of *F. Buskii* from the East, which I predicted in 1903, has been demonstrated in the discovery of a case by Moore and Terrill (1905). The parasite was found at the necropsy of a Laskar sailor from an English steamer, who died at Galveston, Texas, of typhoid fever. This is the only record of the species for this continent, so far as I can ascertain. With regard to their record of the parasite, I wish to call attention to one error which may be the cause of some confusion if not corrected. These authors give the average size of the ova as 150x75 microns. If the magnification assigned to their microphotographs is correct not even the largest reaches this length and the actual size agrees closely with the measurements of Looss cited above. A similar error has been made in the case which Goddard has recently (1907:195) reported from China; the material was referred to a committee, and that part of the report of the investigation committee which deals with the eggs reads as follows: Eggs (possibly immature), size not measured, about one-half that of *Ascaris lumbricoides.* Shell, very thin walled. Contents clear, small and granular; well marked nucleus in center. Nearly spherical. No operculum observed.

An error is certainly present here, for the size of these ova would equal only 40 to 45 microns by 25 to 30 microns on the basis they give in their estimate. This is far too small for *F. Buskii.* If one infers that the proportions relative to *Ascaris lumbricoides* are by accident reversed in their statement, these ova would approximate 130 to 150 microns by 100 to 116 microns; and this again fails to

agree with the species *F. Buskii* to which they assign these specimens. In fact, the designation "nearly spherical" which they use to characterize the ova can not by any means be applied to the figure which Looss gives of ova in *F. Buskii.* Renewed investigations alone can tell whether the authors are in error as regards their measurements and descriptions or with respect to their identification of the species.

Recently Barrois and Noc (1908) reported this species as frequent in Cochin China. Among 133 Annamite prisoners, coming from various provinces, 16 were found on systematic treatment with thymol to be carriers of *F. Buskii.* In 36 autopsies, however, not a single case of infection with this species was discovered. Among the 16 cases infected the flukes were solitary in 5 instances, 3 parasites were present in each of 3 cases, 4, 5, 6, and 24 parasites were found in one case each, and finally even 36 flukes in one case. It is worthy of note that Barrois and Noc think this parasite of little or no consequence unless present in large numbers. In this opinion they are at variance with other observers whose opinions are already cited.

These authors also record the size of the parasite as 25 to 70 mm. in length by 6 to 12 mm. in breadth and 1.5 mm. in thickness. It is longer, they continue, than *Fasciola hepatica,* of which it has not the leaf-like form, but may be most easily distinguished at a glance by its considerable thickness. As regards anatomic details, they merely confirm, in general, the description of Odhner (1902) with the difference that the ovary and shell gland, in place of being situated at the middle of the body, as he indicates, are located about at the union of the anterior and middle third of the body.

In 1887 Poirier described as *Distoma Rathouisi* a new human parasite from a single specimen sent him from China by the Rev. Father Rathouis. According to the record the fluke was passed by a Chinese woman, 35 years of age, at the mission Zi-ka-wei. The woman had suffered long from hepatic pains which were not amenable to treatment. Hence, Poirier concludes that the specimen came from the biliary ducts. Poirier gives an extended description of the anatomy, which he compares in detail with *D. hepaticum,* the well known liver fluke, common throughout Europe in sheep and occasionally also found in man.

For twenty years after its discovery and description Poirier's species was not reported again. Many authors, among whom Leuckart only need be noted, inclined to the view that it was identical with *F. Buskii,* originally reported from India. When the latter species was carefully studied by Odhner his work showed that the two forms were in all probability not identical. A careful examination of the records also indicated to me their evident relationship. Accordingly, in a revision of human trematode parasites, I (1903) included Poirier's form as a distinct species in the genus *Fasciolopsis.* Of Odhner's most recent paper (1909) I shall speak later.

Recently Goddard (1907) reported from Shaohsing, China, two cases of its occurrence. In the first case, a woman, 42 years of age, there was a mixed infection with *F. Buskii.* After the administration of eucalyptus oil, chloroform and castor oil, specimens of both parasites were passed on three successive days. The patient was greatly emaciated, and treatment was delayed so long that she died. An autopsy was impossible. In the second case, a boy, 6 years old, the eggs were found in the feces and administration of eucalyptus oil, as before, brought away many parasites at intervals of two or three days. Two weeks later two specimens were vomited. The patient is still under observation.

According to Goddard, the parasite is common in that region and is thought usually to cause death. The cardinal symptoms are enlarged abdomen, diarrhea, wasting, and occasionally jaundice. The stools are usually light yellow in color and of a peculiarly offensive odor. Goddard observed under the microscope groups of bile stained cells resembling liver cells, sometimes with no definite outline, sometimes three or four lobules held together by the enclosing network of fibrous tissue. Yet he observed no symptoms of liver involvement. Other cases of the disease are under observation.

The specimens from these cases were submitted to Drs. J. L. Maxwell and W. H. Jefferys of The Research Committee, who say that the specimen appears to be *D. Rathouisi,* though the description of this worm on record differs in some particulars from their observations. They had at the same time specimens of *F. Buskii* from the other case, and note emphatically that they "dissent altogether from the statements of Scheube that these two distomata are varieties of the same worm. In our specimen their form, size and

consistency differ in many particulars." The ova are important factors in determining a parasite fluke. Goddard's account of these structures is as follows: The eggs of the *D. Rathouisi* are about two-fifths of the microscopic field under a one-sixth inch objective and one inch ocular, have a thin shell and appear to possess a hyaline body moderately well filled with coarse granules of a greenish yellow tint in fresh feces. These eggs were present in both cases reported. One was a case of mixed infection with *F. Buskii* and the figures given in this report show a difference in size of the ova.

The report of the Investigation Committee to whom these specimens were submitted is given in the same paper (Goddard 1907: 198). The description of the ova reads thus: Eggs, oval, size not measured, about one-third larger than *Ascaris lumbricoides*. Thin walled and smooth with very small operculum. Contents appear to consist of large granules.

I have discussed the records of this species in a recent paper (1908) thus: "From Goddard's account the size of the ova may be estimated as approximately 100-115 microns by 65-75 microns. Such an ovum would be very much smaller than that described by Poirier for his *D. Rathouisi*. The Investigation Committee notes in its report some doubt as to the correctness of the identification, and the doubt is emphasized by this discrepancy in the size of the ova. Further study of these forms is needed to establish their true character."

Since writing the above account, through the great kindness of Dr. Jefferys, I have received three specimens of this parasite of which he writes: "The other worm, of which I can spare you two specimens, is less certain. Maxwell (Tainan, Formosa) believed it to be *D. Rath.*, and I think it possibly is so, though I felt doubtful, as he, too, does now. If the testicles of *D. Rathouisi* are right and left, then this is not that worm. Otherwise it corresponds to such descriptions as given in Braun, for instance. Anatomically it is much like *F. Buskii* and appears in the same patients at times. There are these few differences—it is shorter and thicker in proportion and this factor is constant; that is, if the stool has both kinds of worms, it is easy and simple to place each worm present in one or the other group. It is more regularly oval and does not have wavy edges or lean to one side (See also Goddard's report). As you know, there has always been a doubt as to whether or not

these two worms are the same or different. Personally I am inclined to believe they are the same and that the original description of *D. Rathouisi* was faulty with regard to the position of the testicles. Possibly a difference in date of infection might account for the difference in size, but why can we not have a large breed of worms and a small, as a large breed of horses and a small."[2]

Again, in October, 1908, Dr. Jefferys sent me another lot of the same species; there were nine specimens, which, he writes, were obtained by Goddard, but gives no further data. At the same time, he sent a batch of five flukes labeled "probably *rathouisi* also, passed with last. Seem different to naked eye. Have just acquired and not cleared any yet."

From this material I have been able to make an extended study of this species. The original description of Poirier is in error at many points, but this is not strange, in view of the fact that he only had a single specimen at his disposal. The results of my work may be summed up in the following specific diagnosis.

FASCIOLOPSIS RATHOUISI WARD, 1903.

Syn. *Distomum Rathouisi Poirier,* 1887.

Length 15 to 19 mm., breadth 8.5 to 10.5 mm., thickness up to 3 mm.; shape bluntly oval or elliptical, with short cephalic cone, sharply marked off from body in profile aspect only and usually bent ventrad and even slightly posteriad. Alcoholic specimens light grayish brown, sometimes darker. Usually flexed with dorsum concave and edges only very slightly crenate, if at all. Oral sucker small, subterminal, 0.25 to 0.29 mm. broad by 0.2 mm. in antero-posterior diameter, with cavity looking ventrad, separated from ventral sucker by about twice its own diameter. Acetabulum 1.32

2. It is interesting to note how the observer, after having noted and recorded clearly the differences in external appearance between the two species, is led at the close of his report to question their specific identity on the basis of an argument often advanced and very specious, yet thoroughly fallacious. The fallacies of this argument are so well exposed by Looss in various papers (1899, 1907, et alia) that it would not be profitable to go into them here. I have myself recently (1908) discussed the question with especial reference to the ova and have shown some of the errors which have followed in the past from the assumption of a position such as suggested by Dr. Jefferys. Closely related species of flukes are continually interchanged, and the errors in determination resulting therefrom have led in the past to great confusion.

to 1.38 mm. broad by 0.68 to 0.7 mm. in antero-posterior diameter. Esophagus almost lacking. Internal organs much as in *F. Buskii,* except in detail. Only prominent differences noted here. Intestinal crura somewhat more irregular and probably with more and more pronounced curves. Cirrus sac not conspicuous as in *F. Buskii.* Testes more compactly branched, broader and denser, than in *F. Buskii,* posterior to transverse yolk duct and in median field. Contrary to the report of Poirier they lie one behind the other. Germarium on right side, small, coarsely branched. Uterus in broad, heavy, closely grouped coils, anterior to ovary. Vitellaria outside of intestinal crura from about level of acetabulum to posterior end where they merge without indication of interruption. Masses of acini also drift over intestinal crura toward center of body at several places. Eggs oval, thin shelled, with delicate operculum.

Concerning *F. Rathouisi* in China and its effect on the host Goddard (1907) writes as follows: "This parasite, known to the Chinese as ———, is quite common here and is thought usually to cause death, because the Chinese remedy is so obnoxious to the patient that the parents (for patients are usually children) are too sympathetic to make them take it. The cardinal symptoms are enlarged abdomen, diarrhea, wasting, and occasionally jaundice. The appetite is usually preserved. The cause is supposed to be the excessive eating of aromatic foods, such as peanuts, or, more especially, the eating and drinking of all kinds of things at all times, thus preventing digestion. This produces the worm, so say the Chinese. I am inclined to think the egg may be carried on uncooked vegetables or raw fruit, but thus far have failed to find it.

"The relation of this disease to the liver is interesting. The stools are usually light yellow in color and of a peculiarly offensive odor. Under the microscope I have found groups of bile-stained cells resembling liver cells; sometimes with no definite outline, sometimes three or four lobules held together by the enclosing network of fibrous tissue. Clinically I have observed no symptoms of liver involvement.

"Several other cases of this disease are now under observation and will be reported later on."

To the original case reported by Poirier may be added the two noted by Goddard, and one, sent me by Jefferys in 1908, as noted above, which also comes from Goddard. Two of these are mixed infections; the one of Goddard (1907) being complicated by *F. Buskii* and the last case noted having, as Jefferys writes, another form, of which more later.

Within a very short time I have seen a paper by Odhner (1909) in which, after an examination of Poirier's original specimens from the Paris museum, he endeavors to demonstrate that *D. Rathouisi* represents only a contracted specimen of *F. Buskii.* He rightly points out some errors in the original description of *F. Rathouisi* which include some items given in the above synopsis, and yet I can not possibly share his conclusions. Several good observers in China, among them Jefferys, Goddard and Maxwell (v. a.), note the differences in the appearance of the living specimens. The worms are equally easily distinguished in the alcoholic material. The form differs radically and is constant. The surface is not wrinkled as it would be if noticeably contracted; there is a sort of cephalic cone here which is absent in *F. Buskii.* The uterine coils are more frequent and more filled with ova. The acini of the yolk gland are more numerous and somewhat differently distributed. The suckers are not precisely alike in size, though more nearly so than indicated by Poirier. In short, the differences, while slight, are sufficient to constitute the two forms of different specific rank, and *F. Rathouisi* is undoubtedly a good species.

Among the specimens forwarded to me by Dr. Jefferys in October, 1908, were five which he noted as being different to the eye from *F. Rathouisi,* although they were passed with the batch of that species sent me at the same time. They were somewhat larger than *F. Rathouisi,* measuring 21 to 22 mm. in length by 9 mm. in width. The general aspect is of a larger and slenderer worm and the light yellowish gray color of the alcoholic specimen enables one to pick them out at a glance. At first thought they appeared as transitional forms between *F. Rathouisi* and *F. Buskii* and likely hence to establish the identity of those two forms which has been maintained, but further examination revealed the improbability of this view. The oral sucker is somewhat smaller, the testes different in form and the uterus much more closely coiled. Even if one may suppose that all of these differences are produced by varying

contraction, there yet remains a conspicuous difference in the size of the yolk gland acini which is very striking and apparently beyond modification by contraction or other change in form. It may be that this form represents merely an older specimen of *F. Rathouisi*, but reference to Odhner's figures will show at once that it can hardly be a younger or less developed form of *F. Buskii* since it is in every way fully developed. I am inclined to consider it a new species to which the name *F. Goddardi* may be given. There is hardly opportunity here to discuss the matter in detail. I expect to consider it most extensively in a larger paper on these forms now under preparation. Both figures are drawn from alcoholic specimens and to the same scale.

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EXPLANATION OF PLATES.

PLATE I.

PLATE II.

(Both figures are drawn from alcoholic specimens and to the same scale.)